Proning and the pandemic - ocular complications seen in critical care

Priyanka Sanghi and her co-authors explore the ocular complications seen in critical care units throughout the country as we treat patients through this challenging time.

The SARS-Cov-2 (COVID-19) pandemic has placed the NHS and critical care services under immense strain, with approximately one third of hospitalised patients and 5% of overall cases requiring ventilation support [1]. Prone positioning for durations of 12-16 hours a day has become an integral part of respiratory management of critically unwell patients with COVID-19 [2]. Whilst this is known to improve ventilation-perfusion mismatch [2], it may lead to a variety of ophthalmic complications [3]. This article aims to raise awareness of potential ocular complications related to proning in critical care during the COVID-19 pandemic.

Ocular surface disease

In the intensive care setting, the usual ocular surface defence mechanisms are compromised. Reduced blink and Bell's reflex occurs with use of sedation and neuromuscular blockers, with impaired eyelid closure from inhibition of tonic contraction of the orbicularis oculi [4]. Critically unwell patients are susceptible to fluid imbalances causing conjunctival and lid chemosis, which is further exacerbated with prone positioning [5].

Exposure keratopathy

Exposure keratopathy is reported in up to 60% of critically unwell patients, with higher risk positively correlated with the duration of hospitalisation and depth of sedation [6,7]. Several studies have been published regarding the prevention and treatment of exposure keratopathy within critical care, although the majority of these have not been reviewed specifically in relation to prone positioning where the risk of lagophthalmos is increased [4,5]. Additionally, there is a small risk of COVID-19 transmission via infected tears [8]. Figure 1 illustrates a critical care protocol for ophthalmic care in the COVID-19 era currently being implemented at Barking Havering & Redbridge University Hospitals NHS Trust. This is modified from the Royal College of Ophthalmologists and Intensive Care Society guidelines, taking these factors into account [3,9]. Kerrapro™ (Crawford Healthcare Ltd, Cheshire, UK) is a silicone based dressing commonly used for pressure ulcer prophylaxis on heels and elbows [10]. It may be applied to the superior and lateral aspects of the orbit in the prone position to mitigate the risk of globe compression, and provides mechanical eyelid closure with or without eyelid taping in both supine and prone positions. Alternate four-hourly head turns during proning are generally advised, with the eye towards the mattress the 'dependent' eye, and the eye away from the mattress the 'non-dependent' eye. Lubricants may be applied to the non-dependent eye during these intervals [3].

Microbial keratitis

Untreated exposure keratopathy is the most significant risk factor for the development of microbial keratitis, exacerbated by stagnation of the pre-corneal tear film enabling propagation of pro-inflammatory cytokines and microorganisms [4]. Figure 1 also illustrates preventative measures for exposure keratopathy and thus secondary infection [3]. Bacterial colonisation of the eye is common in intensive care; up to 77% of ventilated patients had at least one pathogen isolated from the ocular surface [11]. The most common causative organism of microbial keratitis is Pseudomonas aeruginosa, which has rapid progression and potential for devastating sight loss [11]. This may occur from respiratory colonisation of Pseudomonas which affects approximately a third of critically unwell patients, in which case conjunctival swabs should be obtained and appropriate antibiotic treatment commenced [3]. Tracheal suctioning should be performed from the side and not across the patient's head, to avoid potential cross-contamination of pathogens onto susceptible ocular surfaces.

Conjunctival chemosis: "the ventilator eye"

Critically unwell patients are more likely to suffer from fluid retention and increased vascular permeability [6,7]. This is exacerbated with the use of positive end-expiratory pressures (PEEP) above 5cm of water, commonly used in patients with COVID-19 to improve ventilation [2,7]. Orbital venous return is compromised with positive pressure ventilation and tight endotracheal tube taping, causing leakage of fluid into periocular tissues [6]. Conjunctival chemosis may affect up to 80% of those receiving positive pressure ventilation, with increased rates of up to 92% in the presence of lagophthalmos [5].

Prone positioning further compounds orbital venous return and increases the degree of conjunctival and facial oedema, with positive correlation between the degree of chemosis and duration of proning [12,13]. This may be reduced by adopting a mild reverse Trendelenburg position, with regular head turns in the prone position to minimise oedema of the 'dependent' eye [12].

Acute angle closure

Proning causes significant rises in intraocular pressure (IOP), with positive correlation between duration of proning and rise in IOP [13,14]. Saran et al. [14] demonstrated a rise in median IOP in critically unwell patients with acute respiratory distress syndrome of approximately 9mmHg just 10 minutes

Table 1: Pharmacological triggers in susceptible eyes: Risk factors for acute angle closure [3].

Anti-cholinergic drugs (atropine, tropicamide, antihistamine H1 & H2 receptor antagonists, nebulised ipratropium bromide)
Adrenergic agonists (phenylephrine, ephedrine, epinephrine (adrenaline), nebulised salbutamol / terbutaline / albuterol)
Sulpha-containing drugs (topiramate, hydrochlorothiazide, cotrimoxazole)
Anti-coagulants (heparin, warfarin, enoxaparin)

OPHTHALMIC CARE IN COVID RESPONSE

Protocol devised in Department of Ophthalmology, Queen's Hospital, Barking Havering & Redbridge University Hospitals NHS Trust, RM7 0AG

INDICATIONS:

- All patients who are intubated / ventilated / sedated / unconscious / GCS < 10
- All patients with neurological problems with loss of blink reflex

ON ADMISSION & DAILY (MINIMUM) CHECK
- Assess and document eyelid position
- Manage as per grading below

EQUIPMENT NEEDED: A bright pen torch
NB: Eyes should be assessed with a pen touch to detect sub-optimal lid closure, masked by patient's eyelashes

GRADE 1

Eye is fully closed:
- Prescribe **eye ointment (see below) three times over 24 hours to both eyes** (see box)
- Clean periocular skin with sterile gauze and sterile water on review
- Review 8-hourly

Eye Ointments:
Xalin Night®, HayloNight®, Simple eye ointment

GRADE 2

Conjunctiva exposed (white of eye):
- Increase frequency of application of **eye ointment to four times a day** to each eye (see box)
- Apply Kerrapro® sheet to closed eyelid; change daily
- Clean periocular skin with sterile gauze and sterile water on review
- Review 6-hourly

GRADE 3

Cornea exposed, showing iris and / or pupil:
- Increase frequency of application of **eye ointment to 2-hourly** (see box) and add **Chloramphenicol 1% eye ointment ON** to affected eye(s)
- Apply Kerrapro® sheet to closed eyelid; change daily
- Clean periocular skin with sterile gauze and sterile water on review
- Review 2-hourly

If the conjunctiva is red and / or there is discharge:
1. Send bacteriology swab from each eye
2. **Stop lubricating eye ointment**
3. Prescribe **Chloramphenicol 1% eye ointment QDS** to both eyes (use a seperate tube for each eye)
4. Increase frequency of eye cleaning to 2-hourly
5. Call for an ophthalmology opinion if not improving within 48 hours

URGENT EYE REVIEW: if the cornea has a white line and / or white spots on the surface:
Signs of infection include redness, discharge +/- lid or conjunctival swelling and / or corneal clouding.

Prone patient:
- Apply Kerrapro® or gel pads to superior and temporal orbit to relieve direct pressure on the globe (eye)
- Ensure both eyelids are fully taped closed
- Perform **routine eye care (cleaning and lubrication)** during **head turn intervals** (4-hourly)
- Revert to above protocol when patient supine

Additional Notes:
1. It is important for all medical personnel to maintain strict hand hygiene & wear eye protection when cleaning eyes.
2. Apply eye cover during open oropharungeal suctioning if patient known to have active respiratory infection.
3. Do not withdraw the suction catheter across patient's face after suctioning.
4. Kerrapro® sheet must be changed once daily.
5. Vaseline may be applied to the periocular skin as an emollient.

For further reference, please see:
http://www.rcophth.ac.uk/wp-content/uploads/2017/11/Intensive-Care-Unit.pdf

Figure 1: Critical care protocol for ophthalmic care currently being implemented at Barking Havering & Redbridge University Hospitals NHS Trust.

post-proning, with an increase of 18mmHg from baseline following 14 hours of proning.

Bilateral and unilateral acute angle closure (AAC) has been reported in sparse case reports following proning for spinal surgeries [3]. The mechanism of this remains unclear, but is suggested to occur in anatomically susceptible eyes with forward movement of the lens-iris diaphragm [13]. Additionally, a number of medications and anaesthetic agents used in critical care have been linked to AAC, as illustrated in Table 1 [3]. Prompt recognition and treatment is essential in this reversible sight-threatening disease.

Ischaemic optic neuropathy

Prone positioning is an established risk factor for ischaemic optic neuropathy (ION) and has been described in several case reports, usually following spinal surgeries with an average duration of proning for 497 +/- 180 minutes [13,15]. The prevalence of ION may increase in the critical care setting with the rise in proning practices and cases of COVID-19 patients with multi-organ failure. Pre-existing cardiovascular risk factors such as hypertension and diabetes mellitus are established risk factors for ION, and have higher prevalence in COVID-19 patients requiring critical care [1,2,13].

The mechanism of ION is deemed to be multi-factorial: hypotension, anaemia, haemodialysis and the use of vasopressors are frequently encountered in the critical care setting, all of which may precipitate ION [13]. Optic nerve perfusion is compromised with rises in IOP and intra-abdominal pressure during proning.

The only clinical sign of ION may be a relative afferent pupillary defect (RAPD) with optic nerve swelling in anterior ION, by which stage sight loss is irreversible. Preventative measures are preferable but may be challenging without compromising life-saving therapies. Prompt correction of hypotension and anaemia is recommended [13].

Retinal vascular occlusions

As for ION, cardiovascular and cerebrovascular disease are significant risk factors for central retinal artery (CRAO) and vein (CRVO) occlusions. Additionally, some reports have shown an association between retinal vascular occlusions and thrombophilia [16]. A pro-inflammatory and hypercoaguable state is widely reported in patients with COVID-19; elevated fibrinogen and D-dimer levels, prolonged prothrombin time and high fibrinogen levels are consistently demonstrated, with multiple reports of systemic venous and arterial thromboembolic complications [2,3,17]. Additionally, retinal vascular occlusions have been rarely reported following prone positioning for orthopaedic procedures, with multiple factors such as hypotension, anaemia, prolonged duration of proning and external globe compression identified as precipitants [18].

Isolated case reports of retinal pathology following COVID-19 infection have emerged, including CRVO, CRAO, acute macula neuroretinopathy (AMN) and paracentral acute middle maculopathy (PAMM) [19-23]. Interestingly, CRVO, AMN and PAMM have been reported in COVID-19 infection not requiring critical care admission, largely with evidence of transient hypercoaguability suggesting prevalence of microvascular sequelae even in mild disease [19-21]. Conversely, case reports of CRAO appear to have occurred in severe COVID-19 infection requiring intubation, although proning was not discussed as a factor [22-23]. Diagnosis of retinal vascular occlusions is challenging in the critical care setting as patients are usually unable to verbalise visual complaints. An ophthalmic opinion is required to confirm diagnosis and follow-up for secondary glaucoma as well as mitigate risk to the fellow eye.

Orbital compartment syndrome

Orbital compartment syndrome (OCS) is a rare ocular emergency which may be induced by prone positioning [24]. An acute rise in intraorbital pressure from fluid accumulation in periorbital tissues may result in irreversible loss of optic nerve perfusion and vision without prompt intervention. Patients with a high body mass index and those on fluid replacement are particularly vulnerable to OCS, compounded by direct globe compression and raised IOP in the prone position. OCS may present as acute proptosis, elevated IOP, significant periorbital oedema and a fixed dilated pupil with or without an RAPD. The conscious patient reports significant visual loss and pain in the affected eye. Urgent recognition and management of these patients with a lateral canthotomy and cantholysis is essential to restore optic nerve perfusion [24]. Sun et al., who demonstrated peri-orbital oedema and a 2-3-fold increase in IOP in two proned patients with COVID-19, advised protective cushioning around the globe to prevent direct compression, with placement of the head above the heart [24].

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TAKE HOME MESSAGE

- Proning may increase the risk of more uncommon ophthalmic complications including ION, CRAO, CRVO, AAC and OCS, and worsen ocular surface disease and conjunctival chemosis.
- Awareness and prompt intervention may prevent sight-threatening visual loss.
- Direct globe compression in the prone position should be avoided with the use of protective cushioning devices such as Kerrapro™, which also provides mechanical eyelid closure.

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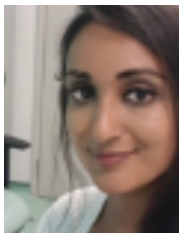

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